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Sir:

Enclosed herewith for filing is the patent application of:

Inventor(s): WILLIAM J. FURNASjc551 U.S. PTO  
09/318249  
05/25/99Title: CONTAINER INSPECTION MACHINE

Enclosed: 3 sheet(s) of drawings:  Formal  2 copies - Informal  
6 pages of SPECIFICATION and ABSTRACT  
3 page(s) of CLAIMS  
 Declaration/Power of Attorney  
 Assignment

Certified Copy from which priority is claimed:

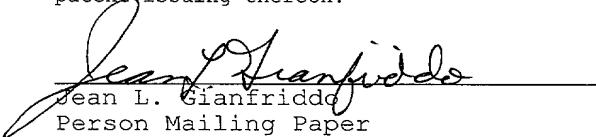
 Attached  Will Follow  Not Applicable

Country: \_\_\_\_\_ Appln. No. \_\_\_\_\_ Filed: \_\_\_\_\_

CLAIMS AS FILED				BASIC FEE
FOR	NUMBER FILED	NUMBER EXTRA	RATE	
TOTAL CLAIMS ALLOWED - 20	- 7 -	- 0 -	X \$ 18.00	- 0 -
INDEPENDENT CLAIMS ALLOWED - 3	- 1 -	- 0 -	X \$ 78.00	- 0 -
MULTIPLE DEPENDENT CLAIMS			\$260.00	- 0 -
FEE FOR RECORDING ASSIGNMENT			\$40.00	40.00
<b>TOTAL FEES</b>				<b>\$800.00</b>

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PATAPPLN.FOR

SPECIFICATION

CONTAINER INSPECTION MACHINE

5       The present invention relates to a machine for inspecting glass or plastic containers such as bottles and more particularly to such a machine which can inspect the sidewall of the container to find defects.

10

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of my co-pending application patent application Serial No. 09/026,311.

The side wall of a glass container can include various types of defects, including an area of unevenness in glass distribution which will provide a lensing effect when backlit (a refractive defect). Container inspection machines, such as shown in U.S. Patent No. 5,004,909, inspect the sidewall of a glass bottle by presenting the bottle in front of a light source defined by alternating black and white stripes. Such an inspection machine can find refractive best when they are located at the edge of the stripe. Container inspection machines, such as shown in U.S. Patent No. 4,601,395, inspect the sidewall of a glass container by presenting the bottle in front of a light source defined by a single bright area that is always in the view of the camera, with transversely spaced outer regions of various intensities and rotating the container.

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OBJECT OF THE INVENTION

It is an object of the present invention to provide a container inspecting machine which will identify a light blocking defect when inspecting also for refractive defects.

35       Other objects and advantages of the present invention will become apparent from the following portion of this specification and from the accompanying drawings which

illustrate in accordance with the mandate of the patent statutes a presently preferred embodiment incorporating the principles of the invention.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a top view of a container inspection machine made in accordance with the teachings of the present invention;

10 Figure 2 is schematic representation showing the operation of the light source shown in Figure 1; and

Figure 3 is a schematic illustration showing the operation of the light source as implemented.

#### BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

15 A bottle 10, which can be either glass or plastic is conveyed from right to left along a conveyor 12 for inspection at the illustrated inspection station where the bottle is imaged on the image of a CCD camera 14. The image is evaluated to identify anomalous pixel readings which are indicative of a defect. 20 Associated with the CCD camera is a controlled light source 16 which defines a large area of light with a large number of vertical rows of L.E.D.s 18 (in the preferred embodiment). As can be seen from Figure 1, the L.E.D.s are focused or aimed so that light will pass through the entire 25 bottle (from top to bottom and from side to side) and be maged on the camera. These vertical rows also are supported to emit light parallel to each other. Each vertical row of L.E.D.s 18 is turned on and off with a field effect transistor (not 30 shown).

In Figure 2, individual timers 20 are connected to each vertical row of L.E.D.'s 18 so that when the rows are turned on, the timers will time out at selected times (0T,.2T,.4T,.6T, and .8T) of an imaging cycle (the time T required for the row 35 of L.E.D.'s to turn fully on and appear white) with light intensity being a function of the time on. In Figure 3, a

single control operates eight rows and defines bit masks 22 which turn on the desired vertical rows for each of four repeated equally timed steps (each step continues for .2T) of an imaging cycle to achieve the same result. The image is 5 defined over the period of these four steps. While these illustrations discuss the use of time to set the desired intensity level, current level could alternately be controlled for the same purpose.

As can be seen from Figure 2, the light source is made up 10 of a number of vertical row groups, each having eight vertical rows. These eight rows proceed from bright to .8 bright, to .6 bright, to .4 bright, to .2 bright and then to .4 bright to .6 bright to .8 bright. While there are five intensity levels (20%, 40%, 60%, 80% and 100%) in the illustrated embodiments, 15 other numbers can be used. By setting the minimum intensity level (20%) high enough so that light blocking defects can be identified, both light blocking defect and refractive defects can be simultaneously identified by the CCD camera over 100% of the area of the light source.

A bottle 10, which can be either glass or plastic is conveyed from right to left along a conveyor 12 for inspection at the illustrated inspection station where the bottle is imaged on the image of a CCD camera 14. The image is evaluated 20 to identify anomalous pixel readings which are indicative of a defect. Associated with the CCD camera is a controlled light source 16 which defines a large area of light. In the preferred embodiment there are a large number of vertical rows 25 of L.E.D.s 18. As can be seen from figure 1, the L.E.D.s are focused or aimed so that light will pass through the entire bottle (from top to bottom and from side to side) and be imaged 30 on the camera. These vertical rows also are supported to emit light parallel to each other and the emitted light passes through a diffuser element. Each vertical row of L.E.D.s 18 is turned on and off with a field effect transistor or the like 35 (not shown).

In Figure 2, an individual timer 20 is connected to each

field effect transistor so that when each row can be turned on for a selected time. The timers will time out at selected times (.2T,.4T,.6T,.8T, 1.0T) of an imaging cycle (here time is equated to the ideal time required for the row of L.E.D.'s to appear illuminated to a selected degree) with light intensity being a function of the time on. For example, .60T is the time that a vertical row of lights must be on for the intensity of the row to appear 60%. For discussion purposes the light of a fully on source is referred to as "white", but it should be understood that the light source may be colored and the illuminated light may in fact be invisible (an infrared L.E.D. for example). Actual "on" times may also be varied to compensate for overlapping illumination effects. Due to overlap of light output, actual "on" times, for a particular column, may need to be modified to achieve a best fit to the desired continuously varying intensity cycle. For example, the full bright (1.0T) columns, which may not get full white because they are getting only partial light from neighboring .8T columns may need to be set at an increased time on (1.15T, for example). Calculations based upon the actual performance of the illumination method, in this case, L.E.D./diffuser combination, will determine the method of calculating corrections to produce the desired spatially cyclically continuously varying intensity between the extremes of dark and light intensity source.

As shown in Figure 3, a single control operates eight rows and defines bit masks 22 which turn on the desired vertical rows for each of each of the four repeated timed steps (as illustrated each step continues for .2T) of an imaging cycle. The image is defined over the period of these five steps. While these illustrations discuss the use of time to set the desired intensity level, current level could alternately be controlled for the same purpose. Other light sources can be used with various light output control over the area methods, such as LCD panel, or printed pattern, in conjunction with a shuttered camera for the same purpose. While there are five

intensity levels (20%, 40%, 60%, 80% and 100%) in the illustrated embodiments, other numbers can be used. A spatially cyclically continuously varying intensity between the 20% bright and light is defined on the light source  
5 illumination area which cyclically changes at a rate of change which is less than that required to be detected as a defect. The minimum brightness level (20%) is chosen so that either a light blocking defect or a refractive defect can be identified by the CCD camera over 100% of the area of the light source.

10 As can be seen from Figure 3, full control over the individual column intensity goes beyond the fractional linearly calculated percentage previously presented. The pattern presented here could be described as a triangle wave whose peak is a full bright and valley is at 20% bright. As can be seen  
15 from Figure 3, full control over the number of columns going from 20% bright to bright can be controlled. Changing the number of columns can be done to optimize the cyclic nature of the pattern for a container size or defect size. The spatially varying intensity cycles may be horizontal or vertical or at some other angle. It may also be a combination of angles.  
20

25 Full control over the relative position of the pattern to the overall backlight (and thus the container to be inspected) can also be controlled. Where the inspection process may use dynamically located zones, the bright portion of the pattern can be optimally placed to aid in the location of the container.

For a one axis cyclic variation, a measure of the light source quality would provide of a nearly flat histogram analysis of the source. A two axis light cyclic light source  
30 could also be used to generate such variations with individual LED control, using a transmissive light control scheme such as a light valve, LCD, or printed pattern. A computer 15 analyzes the camera image by comparing neighboring pixels (one or more away) alone or in combination to determine the rate of change  
35 in intensity to identify defects where the rate of change exceeds a defined value.

CLAIMS

1. A machine for inspecting the wall of a bottle comprising  
a conveyor for supporting a bottle at an inspection  
5 station,  
the inspection station including  
a CCD camera on one side of the conveyor having a  
camera image,  
10 a light source, having an illumination area, on the  
other side of the conveyor, for imaging the bottle on said CCD  
camera image means,  
means for defining a spatially cyclically continuously  
varying intensity between a minimum brightness level that will  
permit the identification of a light blocking defect  
therebehind and light on said light source illumination area at  
15 a rate of change which is less than that required to be  
detected as a defect,  
computer means for analyzing said camera image by  
comparing neighboring pixels (one or more away) alone or in  
combination to determine the rate of change in intensity to  
identify defects where the rate of change exceeds a defined  
value.
2. A machine for inspecting the wall of a bottle according to  
claim 1, wherein said light source comprises a plurality of  
25 L.E.D. rows.
3. A machine for inspecting the wall of a bottle according to  
claim 2, wherein said plurality of L.E.D. rows define a  
30 plurality of row groups each including a light row at one side,  
a row having a minimum brightness, at least one row  
intermediate said white and minimum brightness rows having an  
intensity between minimum brightness and white, and at least  
35 one row on the side of said minimum brightness row remote from  
said white row having an intensity between minimum brightness  
and white.

4. A machine for inspecting the profile and wall of a bottle according to claim 3, wherein there are a plurality of vertical L.E.D. rows intermediate the minimum brightness and white rows  
5 and the intensity of said plurality of intermediate rows uniformly reduces from the white row to the minimum brightness row.

10 5. A machine for inspecting the profile and wall of a bottle according to claim 4, wherein there are a plurality of vertical L.E.D. rows on the side of said minimum brightness row remote from said white row and the intensity of said plurality of said rows on the side of said minimum brightness row remote from said white row uniformly increase in intensity proceeding away  
15 from the minimum brightness row.

20 25

6. A machine for inspecting the profile and wall of a bottle according to claim 5, wherein said minimum brightness row has a brightness level of about 20% and wherein each of said vertical L.E.D. row groups has three vertical rows intermediate said minimum brightness and white rows, with the intensity of the row adjacent the minimum brightness row having an intensity of about 40% of the white row and the intensity of the row adjacent the white row having an intensity of about 80% of the white row and the intensity of the intermediate of the three vertical rows intermediate the minimum brightness row and white rows having an intensity of about 60% of the white row.

30 7. A machine for inspecting the profile and wall of a bottle according to claim 6, wherein each of said vertical L.E.D. row groups has three vertical rows on the side of said minimum brightness row remote from said white row, with the intensity of the row adjacent the minimum brightness row having an intensity of about 40% of the white row and the intensity of

the next row having an intensity of about 60% of the white row and the intensity of the last of the three vertical rows remote from the minimum brightness row having an intensity of about 80% of the white row.

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ABSTRACT

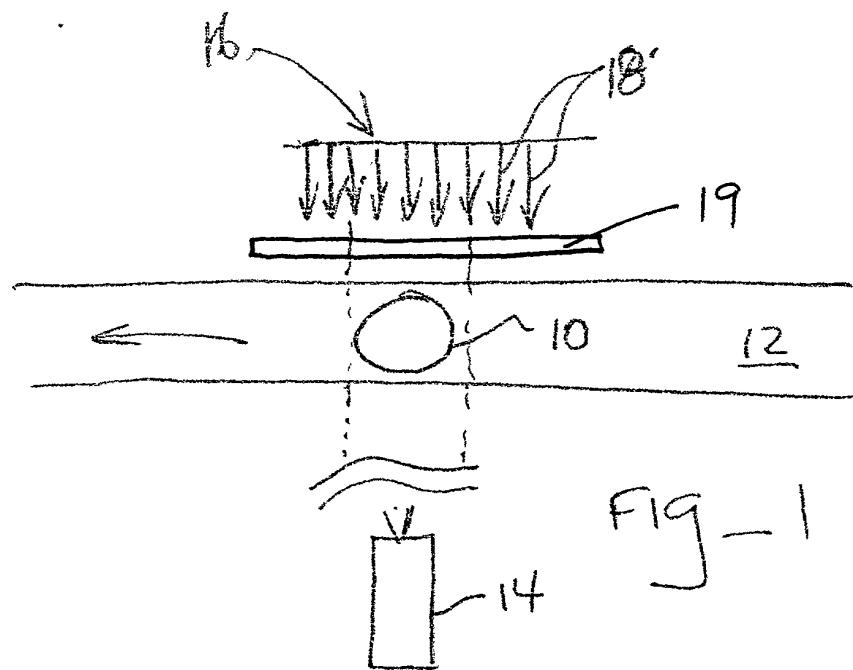
CONTAINER INSPECTION MACHINE

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A machine is disclosed for inspecting the wall of a bottle which is delivered by a conveyor sequentially to an inspection station. A light source defines a plurality of vertical row groups each having no black row, a white row and a plurality of 10 adjacent rows where the intensity systematically decreases to a lowest level where light blocking defects can be seen and than increases systematically to the next white row.

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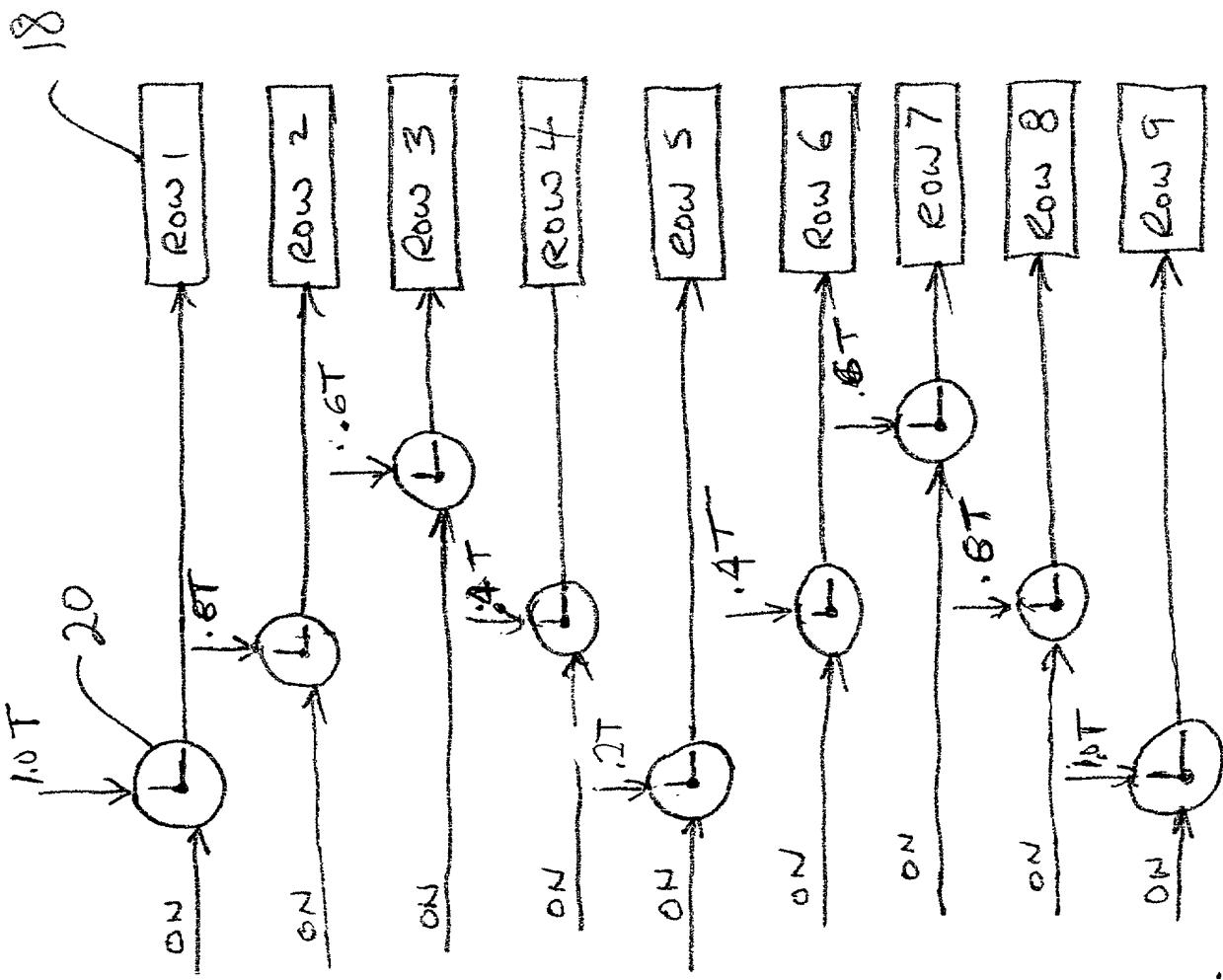


Fig - 2

Step 1 → Rows 1, 2, 3, 4, 5, 6, 7, 8 : ON

2 2

Step 2 → Rows 1, 2, 3, 4, 7, 8 : ON

2 2

Step 3 → Rows 1, 2, 3, 7, 8 : ON

2 2

Step 4 → Rows 1, 2, 8 : ON

2 2

Step 5 → Row 1 : ON

2 2

Fig - 3

## COMBINED DECLARATION AND POWER OF ATTORNEY

## FOR PATENT APPLICATION

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated next to my name; that I believe that I am the original, first and sole inventor (if only one inventor is named below) or an original first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **CONTAINER INSPECTION MACHINE** the specification of which:

is attached hereto

was filed on \_\_\_\_\_, assigned Serial No. \_\_\_\_\_ and was amended on \_\_\_\_\_

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
None (Number)	(Country)	(Month/Day/Year Filed)	Yes	No
(Number)	(Country)	(Month/Day/Year Filed)	Yes	No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application No.)	(Filing Date)	(Status-Patent, Pending, Abandoned)
(Application No.)	(Filing Date)	(Status-Patent, Pending, Abandoned)

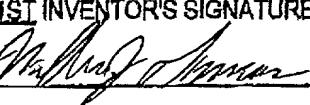
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity or the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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